SUDAN UNIVERSITY OF SCIENCE &TECHNOLIGY
COLLEGE OF GRADUATE STUDIES
DEPARTMENT OF MECHANICAL ENGINEERING

THE EFFECT OF AMBIENT TEMPERATURE UPON GARRI POWER PLANT COMBINED CYCLE

تأثير درجةِ حرارة الجوعلى محطةِ كهرباء قري ذات الدورةً المزدوجة

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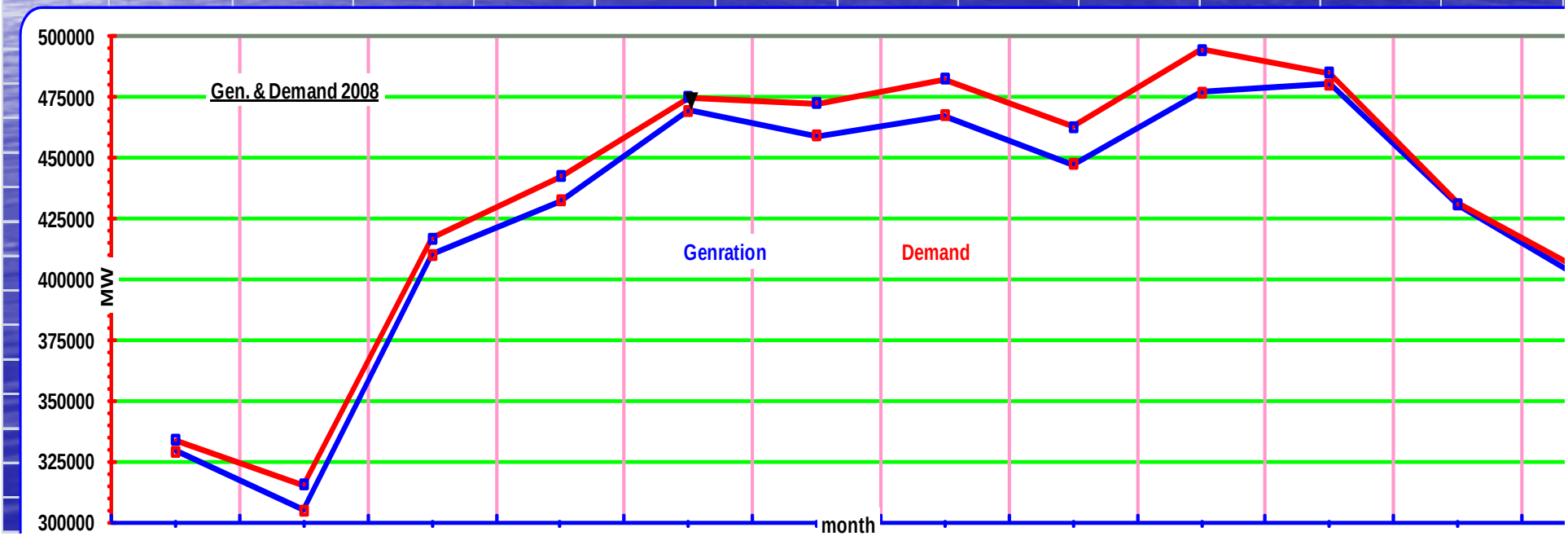
The increase in power demands was require additional power plants in the Sudan or any other source of power supply to meet the demand .

Generation & demand comp.

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
generation	329174	304653	410061	432625	469836	459126	467501	447680	477245	480623	430748	399826
demand	333799	315426	416782	442489	475099	472734	482602	463124	494854	485109	431250	402819
Losses	4625	10773	6721	9864	5263	13608	15101	15444	17609	4486	502	2994
incease %	1.4	3.5	1.6	2.3	1.1	3.0	3.2	3.4	3.7	0.9	0.1	0.7



The main problem was that the units out put were always less than the installed design capacity for all units of this group. This drop of power output is referred to Khartoum climate. This is true if compared to the output at ISO condition(15˚C, 14.7 psia at sea level)

The gas turbines are generally used for large scale power generation. The basic gas turbine cycle has low thermal efficiency, so it is important to look for improved gas turbine based cycles. The following methods are helpful in Increasing the performance

- 1- Inlet Air Cooling
- 2-Steam injected gas turbine cycle (STIG).
- 3- Evaporative Regenerative Gas Turbine Cycle (ERGT)
- 4- Humid Air Turbine (HAT)

- The main purpose of this thesis is to investigate, analyze and calculate the effect of inlet air cooling. This method applies efficiently in garii power plant gas turbine

Gas Turbine Inlet Air Cooling
Available Technologies

- 1. Evaporative cooler
- 2. Fogging system
- 3. Mechanical refrigeration system (direct type)
- 4. Mechanical refrigeration system (indirect type)
- 5. Mechanical refrigeration with ice storage
- 6. Mechanical refrigeration system with chilled water storage
- 7. Single stage Lithium Bromide Absorption chiller
- 8. Two stage Lithium Bromide Absorption chiller

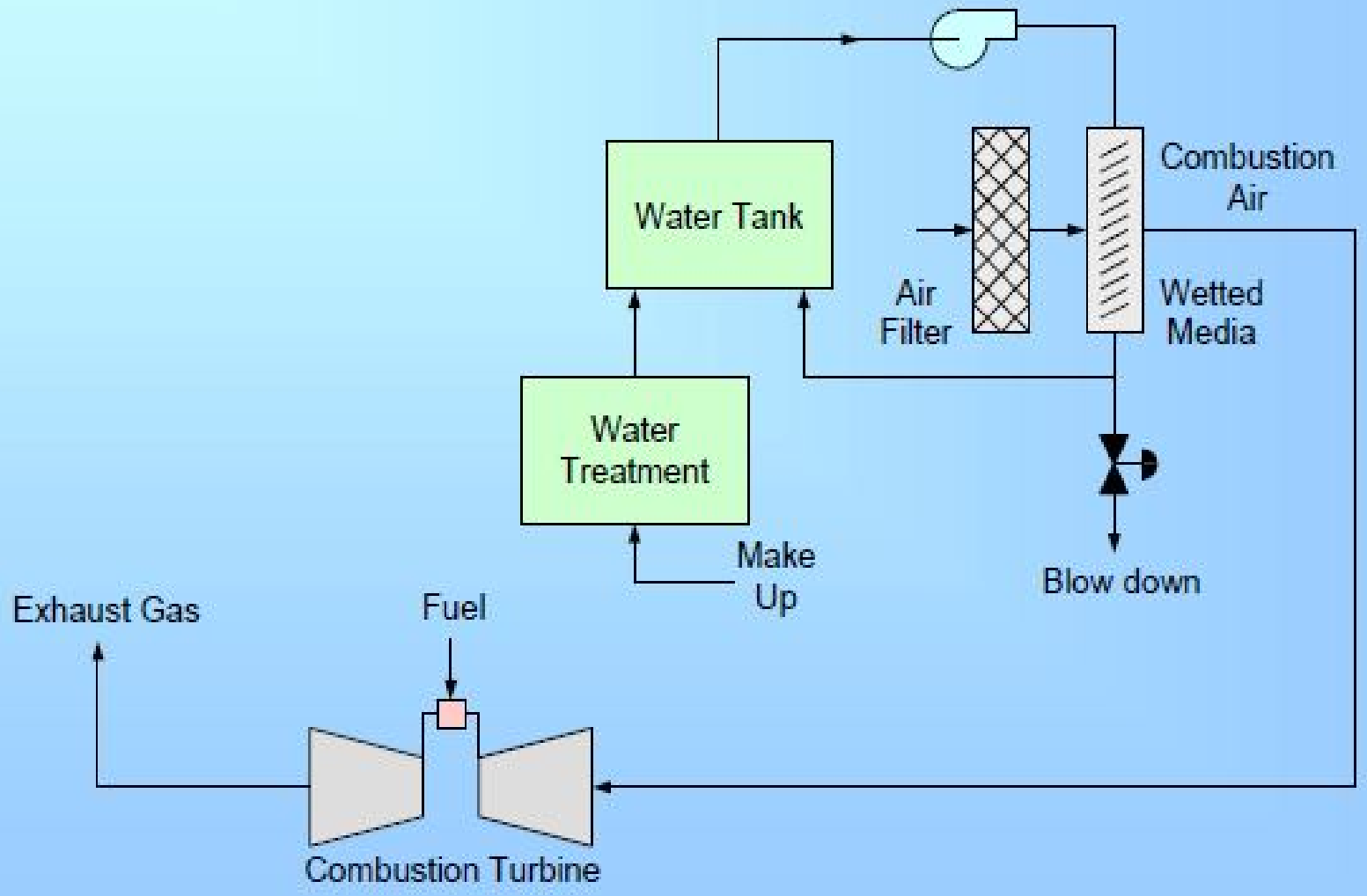
Evaporative cooling system *Advantage*

- evaporative inlet-cooling is economical and simple (Quick delivery and installation time)
- Lowest capital cost & Lowest O&M cost
- Uncomplicated system
- Can operate on raw or treated water(no need demine water)
- suitable for only dry hot climates
- reducing the NOx emissions from the gas turbine (Operates as an air washer and cleans the inlet air.

Evaporative cooling system Disadvantage

- Limitation on capacity improvement
- Highly influenced by the site wet bulb

Schematic of Evaporative Air Cooling



Some photo show erection stapes

after remove cover plate, and check ref.point

Install main water tank

Install lower side plate.

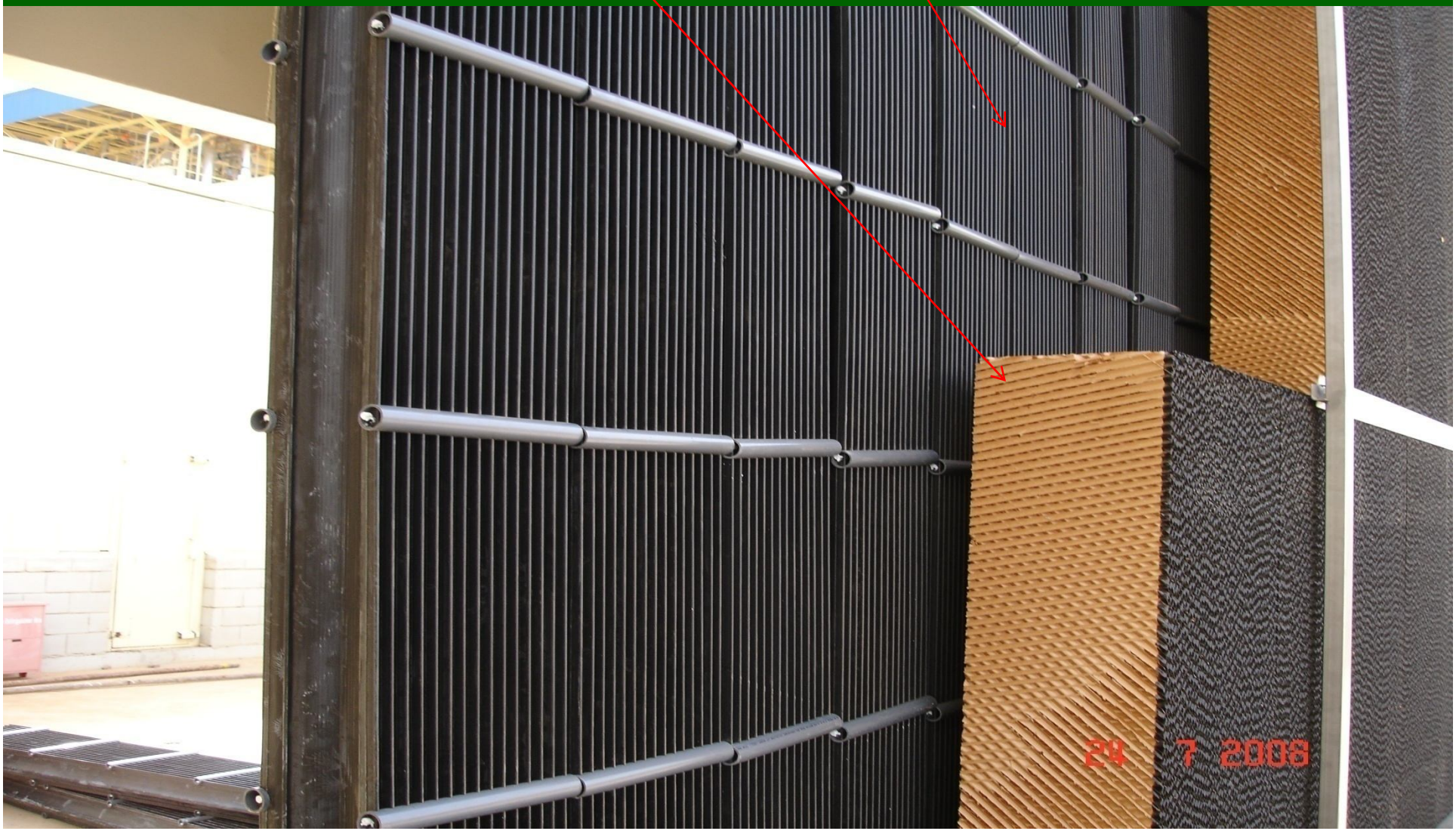
Install intermediate tank.

Install upper side plate. And cooler support

Carry and Install upper tank.

Finish cooler frame

Install The cedlek and drop separator



install the cooler for garii power station gas turbine NO 1 - 4

Erection the evaporative cooler for gas turbine 5-7 garii power plant

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Erection the evaporative cooler for gas turbine 5-7 garii power plant

REMOVE TRANSITION PEACE FROM GAS TURBINE 5-7 TO INSTALL THE COOLER

REMOVE TRANSITION PEACE FROM GAS TURBINE 5-7 TO INSTALL THE COOLER

Install the cooler to the gas turbine

Install the cooler to the gas turbine

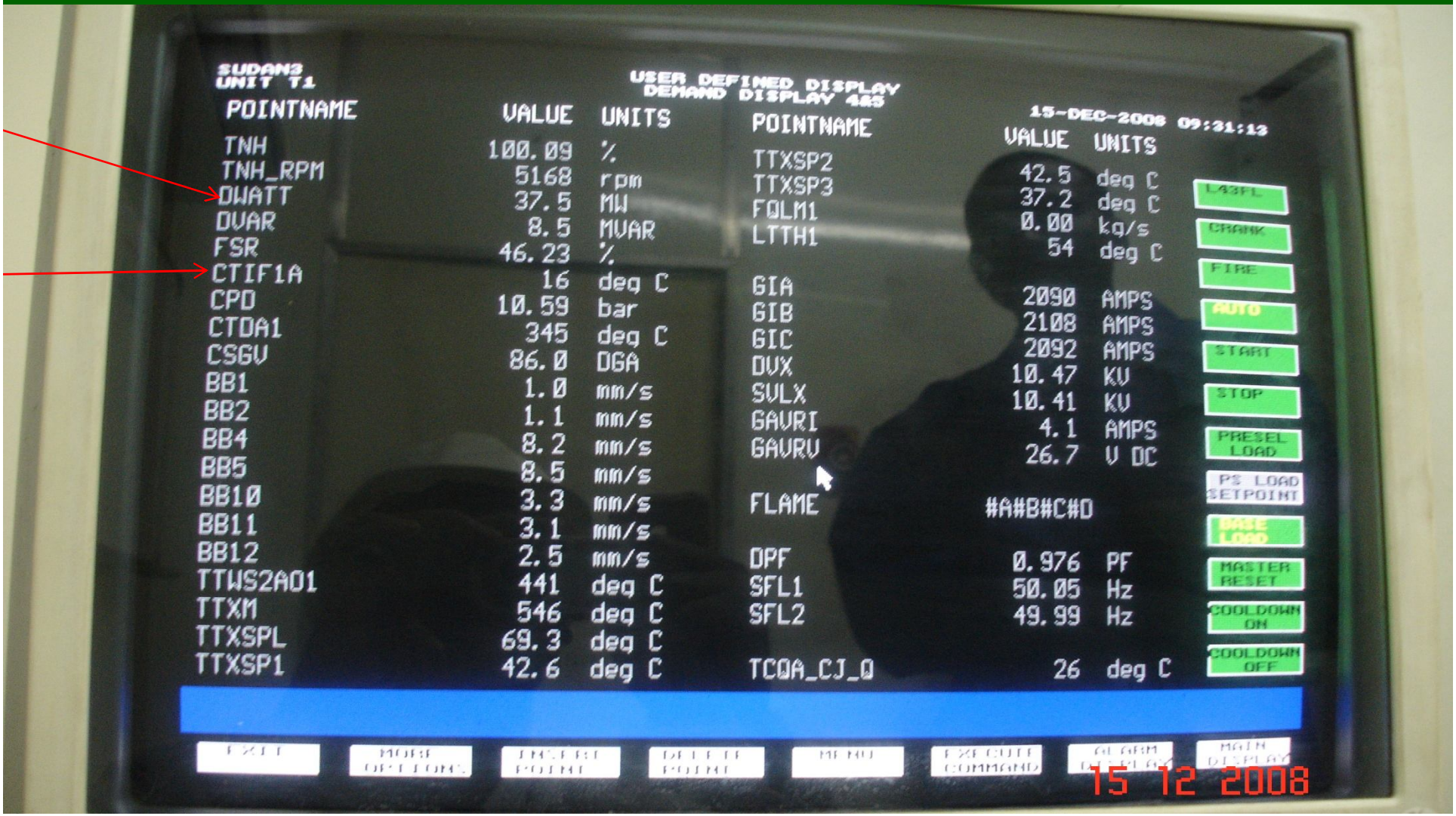
Remove weather hood from GT 8

install the cooler for garii power station gas turbine NO 8

Evaporative cooler control skid

The dust removed from the inlet air after the system running for 6 months

The power for unit 1 increase 5 MW after install the evaporative cooling system



The power generation enhances in garri plant

- 1\ the gas turbine :- 5mwX8units =40MW
- 2\the steam turbine :- 0,5X4units=2 MW
- The total MW enhance = 42MW

Evaporative cooling system cost

The evaporative cooling system which applied in garri combined power plant costs 3763427.65 SDG for material and engineering. 450000 SDG installations cost and allowance for reaction and commissioning team.

PAY PACK PERIOD

- The calculation of the pay back period based on :-
- The system is working 9 months because from 15/10 up to 15/01 yearly the demand for power supply is very low and the system is also working 12hours per day .
- The saving of 42MW=42X12X9X30X1000X0.2=27216000 SDG
- The water consumption for 8 cooler=19X8X12X9X30X0,08= 39398,4 SDG

- The power consumption =3.5X8X12X9X30X0,2=18144 SDG
- The total fuel saving = 2.88 X 12X7X30X1200= 8709120 SDG
- The pay pack period :-

$$\frac{[376342{,}65+39398{,}4+18144+450000]}{[27216000+8709120]}=0{,}119\,year(1.4\,months)$$

- Where:-

  0.2=the price of Kwhr

  0.08= the price of water (in ton)

  1200= the price of fuel LDO (in ton)

  19m3/hr=water consumption per gas turbine

RECOMMENDATIONS

- any new installation of gas turbines in Khartoum area should be With wetted media evaporative cooling system.
- using the inlet air chiller for cooling system in garri power plant Should be investigate due to availability of steam from (HRSG)
- installed the inlet air cooling system for the existing gas turbine Should be looked into. Due to the hot dry climates almost nine months.
- more studies should be done to study the effect of cooling Systems in HRSG